

TABLE OF CONTENTS

Personnel	vii
Publications and Reports	xii
Introduction	xvii
I. Physical Electronics	1
Physical Electronics in the Solid State	1
The Voltage-Current Characteristic of Surface-Dominated Silicon Junctions	1
The Temperature Dependence of Various Current Components in Germanium Esaki Diodes	1
II. Plasma Dynamics	3
Plasma Physics	3
Radiation from Plasmas with Non-Maxwellian Distributions	3
Cesium Vapor Techniques in the Production of Fully Ionized Plasmas	9
Plasma Electronics	15
Thermal Noise from Plasmas	15
Hollow-Cathode Discharge	21
Studies of the Hollow-Cathode Discharge Plasma	22
Superconducting Solenoids – Effects of Magnetic Fields and Currents on the Superconducting Transition	27
Plasma Magnetohydrodynamics and Energy Conversion	31
The Magnetohydrodynamic Rayleigh Problem for the Nonconducting Plate	31
Plasma Magnetohydrodynamic Experiments	40
III. Solid State Physics	47
Research Completed	47
The Elastic Constants of Cadmium from 4.2°K to 300°K	47
The Low-Temperature Specific Heat of a Linear Polymer	47
IV. Microwave Spectroscopy	49
Atomic Recombinations	49
The Generation of Microwave Phonons	49

CONTENTS

V.	Nuclear Magnetic Resonance and Hyperfine Structure	51
	The Hyperfine Structure of Radio-Thallium 199 and 200	51
	Hyperfine Structure in the 3P_1 Level of Hg^{197*}	52
	Hyperfine Structure in the 3P_1 State of Hg^{197}	53
	Direct Measurement of the Hyperfine Splitting of the 3P_1 Level of Hg^{197*}	54
VI.	Microwave Electronics	55
	The X-Line Slow-Wave Structure	55
	Slow Backward Waves in an Electron-Beam Waveguide	58
	One-Dimensional Gap Interaction	63
	Errata	68
	Transmission Zeros of the Four-Cavity Klystron	71
VII.	Molecular Beams	75
	Search for a Small Charge Carried by Molecules	75
VIII.	Satellite Time-Dilation Measurement	81
	Crystal Oscillator Stability Studies	81
IX.	Stroboscopic Research	83
	Pressure-Testing Facility for Oceanographic Equipment	83
X.	Modulation Theory and Systems	85
	Signal-to-Noise Ratios in Limiters with Regenerative Feedback	85
XI.	Statistical Communication Theory	93
	Work Completed	93
	Nonlinear Least-Square Filtering and Frequency Modulation	93
	Discrete Representation of Random Signals	93
	Nonlinear Operators for System Analysis	93
	A Comparison of the Laguerre Set with an Optimum Set for the Expansion of the Past of a Certain Random Process	93
	Noise Analysis in Magnetic Tape Recording	98
	An Iterative Procedure for System Optimization	98
	Optimum Synthesis of a Gaussian Process from a Non-Gaussian Process	106
	An Optimum Method for Signal Transmission	109
	Optimum Compensation for Nonlinear Control Systems	116
	A Problem in Radio Astronomy	125

CONTENTS

XII.	Processing and Transmission of Information	129
	Work Completed	129
	Low -Density Parity-Check Codes	129
	Sequential Transmission of Digital Information with Feedback	129
	Sequential Encoding and Decoding for the Discrete Memoryless Channel	129
XIII.	Physical Acoustics	131
	Distortion of Large-Amplitude Sound Waves in Liquid Helium	131
XIV.	Speech Communication	133
	Binaural Hearing: A Tentative Model and Some Related Experiments	133
	Perception of Sounds Generated by Time- Variant Circuits	134
XV.	Communications Biophysics	139
	Peripheral Nerve Responses to Percutaneous Electric Stimulation in Man	139
	Spectral Analyzer for Electroencephalography	145
XVI.	Neurophysiology	149
	Electrochemical Methods in Hydrodynamic Experiments	149
	Servoanalysis of Postural Reflexes	155
XVII.	Circuit Theory	159
	Phase Invariants	159
XVIII.	Noise in Electron Devices	163
	Parametric Applications of Semiconductor Capacitor Diodes	163
XIX.	Linguistics	165
	Morphophonemic Change in Crow and Hidatsa	165
XX.	Sensory Aids Research	169
	An Encoder for a Grade II Braille Typewriter	169
	Tactile Stimulation of the Fingers as an Information Input to the Blind	171

CONTENTS

XXI.	Shop Notes	173
	Stopcock Bracket	173